IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Applicant:	Achintya K. Bhowmik et al.	§	Art Unit:	2883
Serial No.:	10/601,151	§	Examiner:	Ryan A. Lepisto
Filed:	June 20, 2003	§	Docket:	ITL.0982US P16217
For:	Wideband Arrayed Waveguide Grating	§	Assignee:	Intel Corporation

Mail Stop **Amendment**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF TIMOTHY N. TROP

Sir:

Timothy N. Trop does declare as follows:

1. I am the attorney who prosecuted the above-referenced patent application.

2. We received the file of this application in March, 2003 and prosecuted it diligently, in the normal course, to filing in June, 2003. In particular, a draft was sent on April 24, 2003, comments were received on May 17, 2003, a revised draft was sent on May 21, 2003, comments were received on June 2, 2003, another draft was sent on June 9, 2003, and additional comments were received on June 9, 2003.

3. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 10/14/05

Timothy N. Trop, Reg. No. 28,994

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Applicant:	Achintya K. Bhowmik et al.	Art Unit:	2883
Serial No.:	10/601,151	Examiner:	Ryan A. Lepisto
Filed:	June 20, 2003	Docket:	ITL.0982US P16217
For:	Wideband Arrayed Waveguide Grating	Assignee:	Intel Corporation

Mail Stop **Amendment**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF INVENTORS

Sir:

We, the undersigned, state as follows:

1. We are the joint inventors of the patent application set forth above.

2. We invented the subject matter of the patent application prior to April 23, 2003 as demonstrated by the attached invention disclosure which was submitted prior to April 23, 2003 and which invention disclosure is a true and correct copy of the invention disclosure as submitted with the exception that its submission date is redacted.

3. We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: 10/7/05

Achintya K. Bhowmik

Date: 10/10/05

Biswajit Sur

Rev. 16, 5/02

INTEL INVENTION DISCLOSURE

ATTORNEY-CLIENT PRIVILEGED COMMUNICATION
located at http://legal.intel.com/patent/index.htm

DATE: _____ *OPTICAL-MEMS/IC/PTO*

28462

P16217

It is important to provide accurate and detailed information on this form. The information will be used to evaluate your invention for possible filing as a patent application. **Invention Disclosure forms MUST be sent electronically via email to your manager/supervisor who should then forward with their approval to our email account "invention disclosure submission."** If you have any questions, please call **8-264-0444.**

Last Name: Bhowmik	First Name: Achintya		M.I. K
Intel Phone Number: 408-363-2649	Intel Fax Number: 408-224-3027		Mailstop: EZ1-101
E-mail address: achintya.k.bhowmik@intel.com			WWID: 10654927
Citizenship: Bangladesh	Are you a contractor?	Yes:	No: X
Home Address: 3353 Cortese Cir			
City: San Jose	State: CA	Zip: 95127	Country: USA
Corporate Level Group: NBG	Division: PTO		Subdivision: Integration
Supervisor: Xuejun Ying	WWID: 10074984	M/S: EZ1-101	Phone #: 408-363-2680

Last Name: Sur	First Name: Biswajit		M.I.
Intel Phone Number: 408-363-2632	Intel Fax Number: 408-224-3027		Mailstop: EZ1-101
E-mail address: biswajit.sur@intel.com			WWID: 10071719
Citizenship: India	Are you a contractor?	Yes:	No: X
Home Address: 6915 Rockton Avenue			
City: San Jose	State: CA	Zip: 95119	Country: USA
Corporate Level Group: NBG	Division: PTO		Subdivision: Assembly & Test
Supervisor: K. Murali	WWID: 10049552	M/S: EZ1-101	Phone #: 408-363-2658

Last Name:	First Name:		M.I.
Intel Phone Number:	Intel Fax Number:		Mailstop:
E-mail address:			WWID:
Citizenship:	Are you a contractor?	Yes:	No:
Home Address:			
City:	State:	Zip:	Country:
Corporate Level Group:	Division:		Subdivision:
Supervisor:	WWID:	M/S:	Phone #:

(PROVIDE SAME INFORMATION AS ABOVE FOR EACH ADDITIONAL INVENTOR)

2. Title of Invention:
Novel architecture and method for fabrication of arrayed waveguide grating (de)multiplexer with wideband transmission spectrum

3. What technology/product/process (code name) does your invention relate to (be specific if you can)
Arrayed waveguide grating (AWG), 3-dB coupler, planar lightwave circuit

4. Include several key words to describe the technology area of the invention in addition to # 3 above:
Integrated optics, optical communication networks

5. Stage of development (i.e. % complete, simulations done, test chips if any, etc.):
Simulations and experimental demonstration on test chips done.

6a. Has a description of your invention been (or planned to be) published outside of Intel: No

If YES, was the manuscript submitted for pre-publication approval through the Author Incentive Program:

If YES, please identify the publication and the date published:

6b. Has your invention been used/sold or planned to be used/sold by Intel or others? Not in recent future

If YES, date it was sold or will be sold:

6c. Does this invention relate to technology that is or will be covered by a SIG (special interest group)/standard or specification?
No

If YES, name of SIG/standard/specification:

6d. If the invention is embodied in a semiconductor device, actual or anticipated date of tapeout?
Experimental chips taped out in Q2, 2002

6e. If the invention is software, actual or anticipated date of any beta tests outside Intel:
N/A

7. Was the invention conceived or constructed in collaboration with anyone other than an Intel blue badge employee or in performance of a project involving entities other than Intel (e.g. government, other companies, universities or consortia)? NO: X If YES, name of individual or entity:

8. Is this invention related to any other invention disclosure that you have recently submitted? If so, please give the title and inventors: No

PLEASE READ AND FOLLOW THE DIRECTIONS ON HOW TO WRITE A DESCRIPTION OF YOUR INVENTION

Try to limit your description to 2-3 pages
Do NOT attach a presentation, white paper, or specification
ANSWER ALL OF THE QUESTIONS BELOW

PLEASE SEE NEXT PAGE

Invention Title:

Novel architecture and method for fabrication of arrayed waveguide grating (de)multiplexer with wideband transmission spectrum.

Introduction/Background:

The application of Arrayed Waveguide Grating (AWG) optical filters as wavelength multiplexing (MUX) and demultiplexing (DEMUX) devices in optical communication networks is on a rapid rise. Intel Photonics has recently joined the ranks with world's top AWG manufacturers in terms of the device performance and started shipping sample products to leading optical communications companies. This invention disclosure describes a method to engineer the spectral transfer function of AWG to achieve wideband transmission at a negligible insertion loss penalty that has significant potential to add to the product portfolio of Intel Photonics.

Prior Art:

While most of the commercially available AWGs have gaussian transmission spectral transfer functions that are easy to manufacture, high-speed applications require flat or wide-band profile. Currently such flat spectral shapes are achieved by introducing a horn taper of various profiles, such as parabolic, exponential, sinc, Y-splitter, etc., at the input free-propagation region of the AWG. This approach, however, leads to undesirably higher losses than the Gaussian AWGs (by typically 3 dB) and poses tremendous manufacturing challenges as the horn tapers are very sensitive to fabrication tolerances. This is corroborated by the fact that though Intel Photonics has successfully fabricated world-class gaussian AWGs over a year ago, it is still struggling to produce flat-top AWGs with the conventional approach. Currently there is great demand in the market for low-loss wideband or flat-top AWGs.

Description of the Invention:

Here we propose a new technique to fabricate wideband or flat-top AWGs with low insertion loss that opens up a novel method for manipulating the spectral shape of an AWG. We demonstrate the functionality of the architecture via simulation and preliminary experimental results.

In the proposed method, a specially designed dual channel-spacing gaussian AWG and an array of directional couplers are integrated to achieve the desired transmission spectral profile. The waveguide separation between the AWG channel pairs connected to the same 3dB coupler determines the spectral width of the transmission profile of the device and is chosen to be an appropriate fraction of the primary channel spacing to achieve the desired balance between the bandwidth, crosstalk and insertion loss. The phase difference between the optical beams entering the directional couplers is controlled by choosing appropriate path length difference between the output waveguides of the AWG such that light exits from the intended port of the directional coupler. In order to get a flat spectral shape, the two successive output waveguides of the AWG, that are input to the 3dB couplers, need to have a length difference $\Delta l = (2m+1)\lambda_c / 4n_{eff}$, where m is an integer, λ_c and n_{eff} are the average center wavelength and effective refractive index of the two respective waveguides.

Figure 1 shows the simulated results from a representative device. The primary channel spacing of the gaussian AWG is 100GHz whereas the spacing between the channels connected to the 3dB coupler is four times smaller, i.e., 25 GHz. The spectra from the gaussian AWG is shown in Figure 1(a), whereas the spectra from the integrated device is shown in Figure 1(b). These results clearly demonstrate the ability to obtain flat-top spectral shape of the AWG by the proposed technique. The simulated results indicate only 1dB excess loss compared to the gaussian AWG and ~40dB adjacent crosstalk, which are world-class numbers.

This technique to engineer the spectral shape of an AWG can be implemented by both monolithic or hybrid approach. The AWG and directional coupler structures are fabricated on the same chip in the monolithic approach, while they are fabricated separately and later bonded together in the hybrid approach.

We present preliminary experimental results that were obtained by directly bonding two optical chips in a multi-chip module (MCM) format, one with a Gaussian AWG and one with an array of 3-dB couplers. Figure 2 shows a photograph of the fiber-interfaced and packaged device. Figure 3 shows the spectra measured on the multi-chip module die. The performance of this experimental device was not optimized since already available gaussian AWG with uniform channel spacing was used for quick demonstration.

Value to Intel

This invention would potentially be of great value to Intel, specifically the Photonics Technology Operation (PTO), which is seeking to enter the lucrative optical components market. The components required to fabricate the device described in this disclosure, Gaussian AWG and 3-dB coupler arrays, are currently being manufactured by PTO. The proposed device structure can be integrated in planar lightwave circuits (PLC) along with other active and passive optical components.

Likely Infringements

Likely patent infringers would be manufacturers of optical components, such as Lucent Technologies, JDS-Uniphase, Corning Incorporated, Nortel Networks, etc. Infringement could be easily detected through inspection of the device structure.

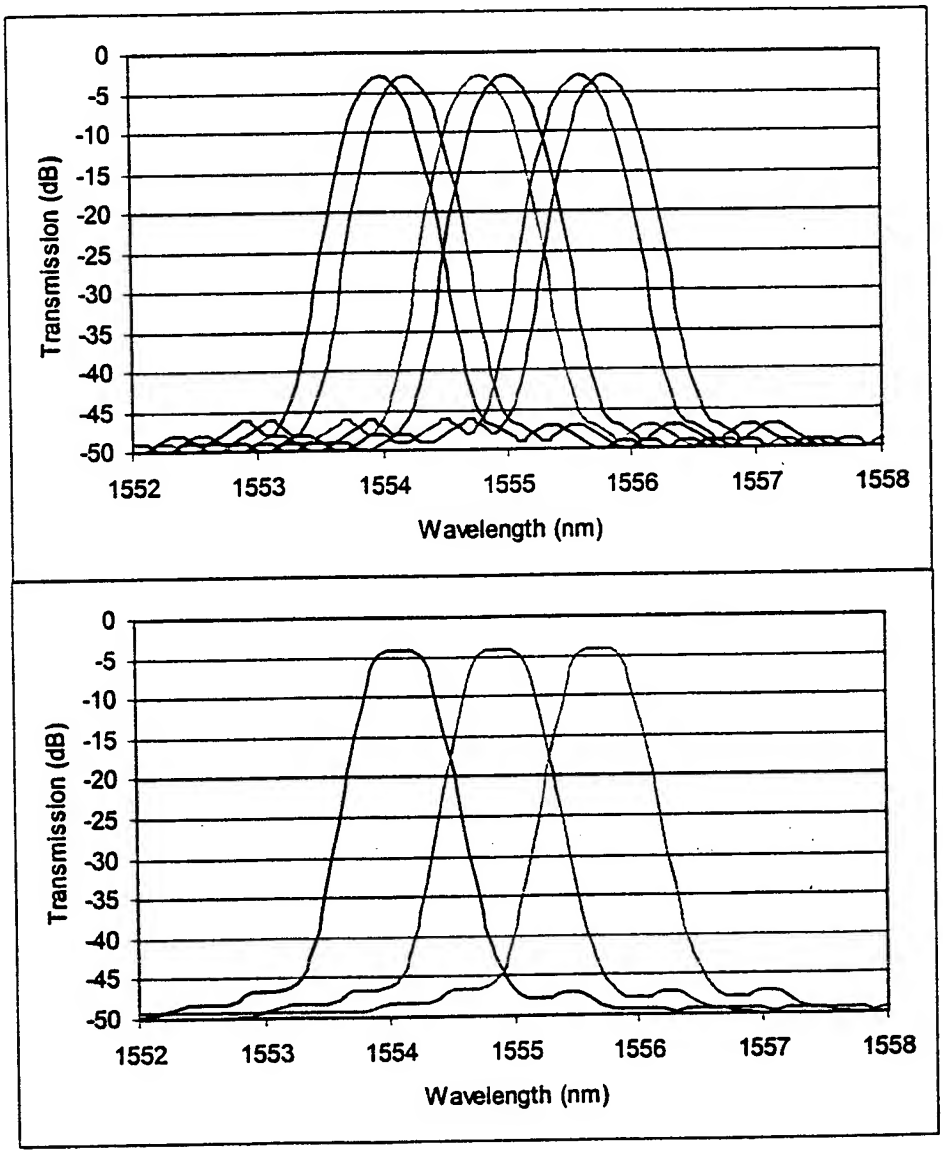

Fig. 1. Top figure shows the simulated transmission spectrum of a dual channel-spacing gaussian AWG with the primary channel-spacing of 100GHz and the secondary channel-spacing of 25GHz. Bottom figure shows the spectrum from the integrated device in which the 25GHz spaced channels are connected to 3dB couplers with appropriately designed arm lengths.

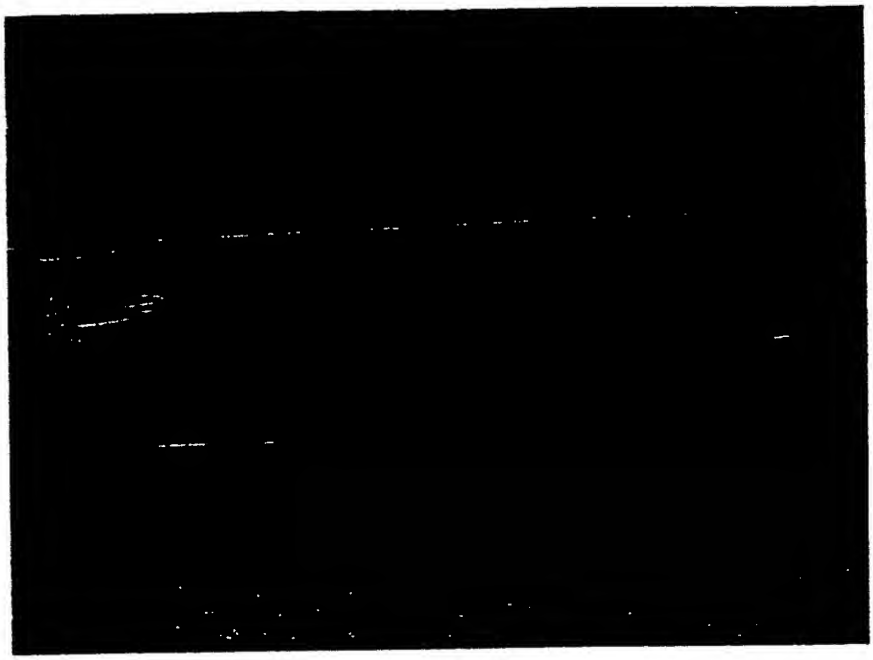

Fig. 2. Photograph of the fabricated and completely packaged multi-chip module. The device is fiber-interfaced with multi-fiber ribbon aligned with a V-groove block.

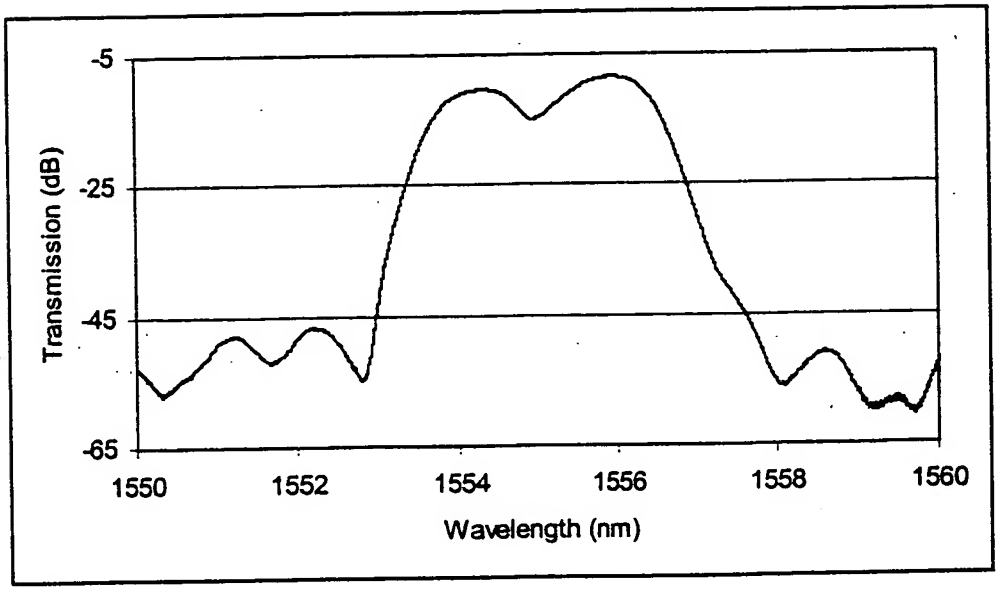

Fig. 3. Measured optical transmission spectrum from one of the channels of the device. This clearly demonstrates the achievement of wideband transfer function with the spectral bandwidth about twice that of the original Gaussian AWG chip.

HAVE YOUR SUPERVISOR READ AND FORWARD IT ELECTRONICALLY VIA E-MAIL TO "INVENTION DISCLOSURE SUBMISSION"

DATE: _____ SUPERVISOR: _____

BY APPROVING, I (SUPERVISOR) ACKNOWLEDGE THAT I HAVE READ AND UNDERSTAND THIS DISCLOSURE, AND RECOMMEND THAT THE HONORARIUM BE PAID